

QUIZ NAVIGATION

	Rose Wang
1	2
3	4
5	✓
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✓	✓

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Started on	Tuesday, 15 October 2024, 2:11 AM
State	Finished
Completed on	Tuesday, 15 October 2024, 2:18 AM
Time taken	7 mins 53 secs
Marks	7.0/9.0
Grade	77.8 out of 100.0

Question 1

ID: 54376

Correct

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THE NEXT 4 QUESTIONS INCLUSIVE REFER TO THE FOLLOWING CASE:

AW, a 59-year-old male weighing 81 kg, is admitted to the hospital with dizziness, loss of energy, and increased edema of the lower extremities.

His medical history includes hypertension for 20 years. He is on hydrochlorothiazide 12.5 mg daily and ramipril 10 mg daily. He tells you that he does not take his medications because he feels fine. Last month, he had an upper respiratory tract infection for which he was prescribed levofloxacin 750 mg daily x 5 days.

Physical examination reveals:

- Blood pressure of 162/95 mmHg
- Moderate edema of the ankles

Laboratory results include:

- BUN - 24 mmol/L
- Fasting blood sugar - 13 mmol/L
- Hemoglobin - 100 g/L
- Serum potassium - 5.9 mmol/L
- Serum calcium - 1.9 mmol/L
- Serum creatinine - 350 umol/L
- Microscopic urine analysis indicates mild albuminuria

AW's history, physical examination, laboratory values and current signs and symptoms suggest that he has:

Select one:

- Acute renal injury due to sepsis from unresolved infection ✗
- Acute renal injury as a result of levofloxacin prescription ✗
- Chronic kidney disease secondary to uncontrolled diabetes ✗
- Chronic kidney disease secondary to uncontrolled hypertension ✓

Rose Wang (ID:113212) this answer is correct. AW's elevated serum creatinine, calcium, potassium, and reduced hemoglobin indicate underlying chronic kidney disease.

Correct

Marks for this submission: 1.0/1.0.

TOPIC: Chronic kidney disease**LEARNING OBJECTIVE:**

To understand the definition, signs, and symptoms of chronic kidney disease.

BACKGROUND:

Chronic kidney disease (CKD) is defined by the presence of kidney damage or a decrease in kidney function lasting for at least three months. The first sign of CKD is often a reduction in creatinine clearance and/or proteinuria. The staging of CKD is as follows:

CKD Staging

Kidney Function Stage	eGFR (ml/min/1.73m ²)
G1 – normal or high	≥90
G2 – Mildly decreased	60 - 89
G3a – Mildly to moderately decreased	45 - 59
G3b – moderately to severely decreased	30 - 44
G4 – severely decreased	15 - 29
G5 – kidney failure	<15 or on dialysis

Albuminuria Stage**Albuminuria (mg/mmol)**

A1	<0
A2	3 - 30
A3	>30

Other changes in bloodwork include:

- Decreased hemoglobin, hematocrit, and ferritin
- Decreased calcium
- Decreased bicarbonate (i.e., a shift towards metabolic acidosis)
- Increased phosphate
- Increased potassium

Symptoms often begin to appear at stage G3b. Symptoms initially are mild but can progress and become severe as kidney function continues to drop. Symptoms include:

- Confusion
- Lack of energy
- Pruritis
- Lack of appetite
- Edema
- Lack of urination
- Nausea (in severe CKD)

Causes of CKD

Primary Causes	Secondary Causes
Glomerulonephritis	Hyperension
Polycystic kidney disease	Diabetes
Alport Syndrome	Acute kidney injury
Abnormal kidney development	Lupus
	Renal obstruction (e.g., kidney stones, benign prostate hypertrophy, tumour)
	Recurring urinary tract infections
	Certain medications (e.g., lithium)

Hypertension and diabetes are the cause of approximately two-thirds of all CKD cases.

RATIONALE:

Correct Answer:

- **Chronic kidney disease secondary to uncontrolled hypertension** - AW's elevated serum creatinine, calcium, potassium, and reduced hemoglobin indicate underlying chronic kidney disease.

Incorrect Answers:

- **Acute renal injury due to sepsis from unresolved infection** - AW is not presenting with any symptoms resembling sepsis.
- **Acute renal injury as a result of levofloxacin prescription** - Levofloxacin would have caused acute renal injury during the treatment course, not a month later.
- **Chronic kidney disease secondary to uncontrolled diabetes** - Although AW likely has diabetes given elevated fasting blood sugar, there is a more likely diagnosis.

TAKEAWAY/KEY POINTS:

Chronic kidney disease (CKD) most often occurs as a complication of uncontrolled hypertension and/or diabetes. CKD is often asymptomatic until stage G3b and so it is usually diagnosed via bloodwork, assuming patients are monitored regularly and have annual check-ups.

REFERENCE:

[1] KDIGO 2017 clinical practice guideline update for the diagnosis, evaluation, prevention, and treatment of chronic kidney disease – mineral and bone disorder (CKD-MBD). Kidney International Supplements. 2017;7(1). doi: <http://dx.doi.org/10.1016/j.kisu.2017.04.001>.

[2] About chronic kidney disease. National Kidney Foundation. <https://www.kidney.org/atoz/content/about-chronic-kidney-disease>. Updated February 15, 2017.

The correct answer is: Chronic kidney disease secondary to uncontrolled hypertension

Question 2

ID: 54380

Incorrect

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Treatment of AW's edema includes all of the following EXCEPT:

Select one:

- Sodium restriction X
- Furosemide X
- Dialysis ✓
- Bumetanide X

Rose Wang (ID: 113212) this answer is incorrect. In healthy individuals and those with chronic kidney disease, the maximum recommended daily sodium intake is 2.3 grams.

Incorrect

Marks for this submission: 0.0/1.0.

TOPIC: Chronic kidney disease

LEARNING OBJECTIVE:

To understand the symptoms of chronic kidney disease and management of edema.

BACKGROUND:

Chronic kidney disease (CKD) is defined by the presence of kidney damage or a decrease in kidney function lasting for at least three months. The first sign of CKD is often a reduction in creatinine clearance and/or proteinuria. The staging of CKD is as follows:

CKD Staging

Kidney Function Stage	eGFR (ml/min/1.73m ²)
G1 – normal or high	≥90
G2 – Mildly decreased	60 - 89
G3a – Mildly to moderately decreased	45 - 59
G3b – moderately to severely decreased	30 - 44
G4 – severely decreased	15 - 29
G5 – kidney failure	<15 or on dialysis

Albuminuria Stage	Albuminuria (mg/mmol)
A1	<3
A2	3 - 30
A3	>30

Other changes in bloodwork include:

- Decreased hemoglobin, hematocrit, and ferritin
- Decreased calcium
- Decreased bicarbonate (i.e., a shift towards metabolic acidosis)
- Increased phosphate
- Increased potassium

Symptoms often begin to appear at stage G3b. Symptoms initially are mild but can progress and become severe as kidney function continues to decline. Symptoms include:

- Confusion
- Lack of energy
- Pruritis
- Lack of appetite
- Edema
- Lack of urination
- Nausea (in severe CKD)

Edema is very common in CKD as kidney dysfunction results in water and salt retention. Edema can easily affect a patient's quality of life as it can affect any part of the body, including the lungs. Edema can cause difficulty breathing, remaining mobile, and decreased energy level. Edema is commonly managed using diuretics to get rid of excess fluid. Having patients weigh themselves before and after starting a diuretic can be useful in optimizing diuretic dose.

Causes of CKD

Primary Causes	Secondary Causes
Glomerulonephritis	Hypertension
Polycystic kidney disease	Diabetes
Alport Syndrome	Acute kidney injury
Abnormal kidney development	Lupus
	Renal obstruction (e.g., kidney stones, benign prostate hypertrophy, tumor)
	Recurring urinary tract infections
	Certain medications (e.g., lithium)

Hypertension and diabetes are the cause of approximately two-thirds of all CKD cases.

RATIONALE:

Correct Answer:

- **Dialysis** - AW's edema is not severe enough to be life-threatening, and so dialysis is not indicated.

Incorrect Answers:

- **Sodium restriction** - In healthy individuals and those with chronic kidney disease, the maximum recommended daily sodium intake is 2.3 grams.
- **Furosemide** - Furosemide can be used to reduce edema and fluid retention.
- **Bumetanide** - Bumetanide, a diuretic, can be used to reduce edema.

TAKEAWAY/KEY POINTS:

Edema as a complication of chronic kidney disease can range from mild to life-threatening, and the severity of the edema helps determine how aggressively to treat the edema.

REFERENCE:

[1] KDIGO 2017 clinical practice guideline update for the diagnosis, evaluation, prevention, and treatment of chronic kidney disease – mineral and bone disorder (CKD-MBD). *Kidney International Supplements*. 2017;7(1). doi: <http://dx.doi.org/10.1016/j.kisup.2017.04.001>.

[2] KDIGO clinical practice guidelines for the management of blood pressure in chronic kidney disease. *Kidney International Supplements*. 2012;2(5). doi:10.1038/kisup.2012.53.

[3] About chronic kidney disease. National Kidney Foundation. <https://www.kidney.org/atoz/content/about-chronic-kidney-disease>, Updated February 15, 2017.

The correct answer is: Dialysis

Question 3

ID: 54384

Correct

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The most likely cause for AW's low hemoglobin is:

Select one:

- Decreased erythropoietin ✓
- Iron deficiency ✗
- Vitamin B12 deficiency ✗
- Folic acid deficiency ✗

Rose Wang (ID:113212) this answer is correct. As chronic kidney disease progresses, the kidney's production of erythropoietin decreases and results in decreased hemoglobin.

Correct

Marks for this submission: 1.0/1.0.

TOPIC: Chronic kidney disease

LEARNING OBJECTIVE:

To understand kidney function in order to identify complications of chronic kidney disease.

BACKGROUND:

The kidneys filter about half a cup of blood per minute and are responsible for the following:

- Optimizing acid-base balance
 - The kidneys secrete hydrogen into the forming urine in order to raise blood pH
- Regulating electrolyte levels

- The kidneys' absorption and secretion of sodium is affected by the renin-angiotensin-aldosterone system (RAAS) and antidiuretic hormone (ADH)
- Potassium moves in the opposite direction of sodium (e.g., potassium is excreted into the urine if sodium is reabsorbed)
- Chloride is regulated along with sodium via sodium-chloride symporter (i.e., co-transporter) channels in the kidneys
- Regulating calcium and phosphate levels**
 - If serum calcium levels are low, parathyroid hormone (PTH) is released and stimulates the kidney to reabsorb calcium into the blood and excrete phosphate into the urine
 - If serum calcium levels are normal or high, PTH level is reduced, resulting in calcium excretion into urine and reabsorption of phosphate
- Vitamin D activation**
 - PTH stimulates renal conversion of 25-hydroxycholecalciferol (i.e., calcidiol) into 1,25-hydroxycholecalciferol (i.e., calcitriol)
 - Calcitriol is the active form of vitamin D, which increases gut uptake of calcium
- Optimizing red blood cell production**
 - The kidneys release erythropoietin (EPO) in response to low oxygen levels in the filtered blood
 - EPO stimulates the bone marrow to produce more red blood cells
- Regulating blood pressure**
 - Cells surrounding the kidneys' afferent arteriole release renin in response to low blood pressure
 - Renin is converted to angiotensin I, which in turn is converted into angiotensin II
 - Angiotensin II is responsible for the immediate systemic vasoconstriction, as well as a sustained release of aldosterone
 - Aldosterone causes sodium reabsorption in the kidney, resulting in fluid retention and blood pressure increase
- Getting rid of waste such as drug metabolites**

RATIONALE:

Correct Answer:

- Decreased erythropoietin** - As chronic kidney disease progresses, the kidneys' production of erythropoietin decreases and results in decreased hemoglobin.

Incorrect Answers:

- Iron deficiency** - This is not the most likely cause of AW's decreased hemoglobin.
- Vitamin B12 deficiency** - This is not the most likely cause of AW's decreased hemoglobin.
- Folic acid deficiency** - This is not the most likely cause of AW's decreased hemoglobin.

TAKEAWAY/KEY POINTS:

The kidneys are responsible for regulating serum electrolyte levels, acid-base hemostasis, calcium levels, blood pressure, and getting rid of waste.

REFERENCE:

[1] OpenStax. *Anatomy & Physiology*. OpenStax CNX. 2016. <http://cnx.org/contents/14fb4ad7-39a1-4eee-ab6e-3ef2482e3e22@8.24>.

The correct answer is: Decreased erythropoietin

Question 4

ID: 54385

Correct

Flag question

When should dialysis be considered for AW?

Select one:

- As soon as possible to prevent additional complications from reduced kidney function ✗
- If AW's uremic state remains unchanged following treatment with medication ✓
- On an intermittent basis in response to AW's lab work and physical symptoms ✗
- As soon as possible and continue until AW qualifies for kidney transplant ✗

Rose Wang (ID:113212) this answer is correct. Less invasive medical management is preferred before dialysis unless the patient is in absolutely critical condition.

Correct

Marks for this submission: 1.0/1.0.

LEARNING OBJECTIVE:

To understand the definition of chronic kidney disease and when dialysis should be considered as a treatment option.

BACKGROUND:

Chronic kidney disease (CKD) is defined by the presence of kidney damage or a decrease in kidney function lasting for at least three months. The first sign of CKD is often a reduction in creatinine clearance and/or proteinuria. The staging of CKD is as follows:

CKD Staging

Kidney Function Stage	eGFR (ml/min/1.73m ²)
G1 - normal or high	≥90
G2 – Mildly decreased	60 - 89
G3a – Mildly to moderately decreased	45 - 59
G3b – moderately to severely decreased	30 - 44
G4 – severely decreased	15 - 29
G5 – kidney failure	<15 or on dialysis

Albuminuria Stage	Albuminuria (mg/mmol)
A1	<3
A2	3 - 30
A3	>30

Other changes in bloodwork include:

- Decreased hemoglobin, hematocrit, and ferritin
- Decreased calcium
- Decreased bicarbonate (i.e., shift towards metabolic acidosis)
- Increased phosphate
- Increased potassium

Symptoms often begin to appear at stage G3b. Symptoms initially are mild but can progress and become severe as kidney function continues to drop. Symptoms include:

- Confusion
- Lack of energy
- Pruritis
- Lack of appetite
- Edema
- Lack of urination
- Nausea (in severe CKD)

Causes of CKD

Primary Causes	Secondary Causes
Glomerulonephritis	Hypertension
Polycystic kidney disease	Diabetes
Alport Syndrome	Acute kidney injury
Abnormal kidney development	Lupus
	Renal obstruction (e.g., kidney stones, benign prostate hypertrophy, tumour)
	Recurring urinary tract infections
	Certain medications (e.g., lithium)

Hypertension and diabetes are the cause of approximately two-thirds of all CKD cases.

Dialysis initiation is recommended if one or more of the following occur and cannot be controlled with less invasive interventions:

- Signs of kidney failure begin (e.g., acid-base irregularities, severe pruritis)

- Inability to control volume or blood pressure
- Progressive deterioration in nutritional status due to dietary intervention
- Mental impairment

GFR is usually around 5 - 10 ml/min/1.73 m² by the time these symptoms are severe enough to require dialysis.

RATIONALE:

Correct Answer:

- **If AW's uremic state remains unchanged following treatment with medication** - Less invasive medical management is preferred before dialysis unless the patient is in absolutely critical condition.

Incorrect Answers:

- **As soon as possible to prevent additional complications from reduced kidney function** - Less invasive medication management is first-line due to potential complications with dialysis.
- **On an intermittent basis in response to AW's lab work and physical symptoms** - This is not the best utilization of dialysis in chronic kidney disease.
- **As soon as possible and continue until AW qualifies for kidney transplant** - Less invasive medication management is first-line due to potential complications with dialysis.

TAKEAWAY/KEY POINTS:

Chronic kidney disease (CKD) is often asymptomatic until stage G3b and so it is usually diagnosed via bloodwork, assuming patients are monitored regularly and have annual check-ups. Dialysis is withheld until CKD symptoms are severe enough that they cannot be managed with medication or other less invasive interventions.

REFERENCE:

[1] KDIGO 2012 clinical practice guidelines for the evaluation and management of chronic kidney disease. *Kidney International Supplements*. 2013;3(1). doi: 10.1038/kisup.2012.73.

[2] KDIGO 2017 clinical practice guideline update for the diagnosis, evaluation, prevention, and treatment of chronic kidney disease – mineral and bone disorder (CKD-MBD). *Kidney International Supplements*. 2017;7(1). doi: http://dx.doi.org/10.1016/j.kisu.2017.04.001.

[3] About chronic kidney disease. National Kidney Foundation. <https://www.kidney.org/atoz/content/about-chronic-kidney-disease>. Updated February 15, 2017.

The correct answer is: If AW's uremic state remains unchanged following treatment with medication

Question 5

ID: 54415

Correct

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Which of the following statements best describes the relationship between hypertension and chronic kidney disease?

Select one:

- Hypertension is not a well known risk factor for the development of chronic kidney disease ✗
- Blood pressure should be <130/80 mmHg to prevent the progression of kidney disease in all patients ✗
- Uncontrolled hypertension is a significant risk factor for kidney failure ✓

Rose Wang (ID:113212) this answer is correct. Uncontrolled hypertension can cause and worsen chronic kidney disease and lead to kidney failure.

- Kidney disease progression can be stopped by controlling hypertension ✗

Correct

Marks for this submission: 1.0/1.0.

TOPIC: Chronic kidney disease

LEARNING OBJECTIVE:

To understand the relationship between chronic kidney disease and hypertension.

BACKGROUND:

Chronic kidney disease (CKD) is defined by the presence of kidney damage or a decrease in kidney function lasting for at least three months. The first sign of CKD is often a reduction in creatinine clearance and/or proteinuria. The staging of CKD is as follows:

CKD Staging

Kidney Function Stage	eGFR (ml/min/1.73m ²)
G1 - normal or high	≥90
G2 – Mildly decreased	60 - 89

G3a – Mildly to moderately decreased	45 - 59
G3b – moderately to severely decreased	30 - 44
G4 – severely decreased	15 - 29
G5 – kidney failure	<15 or on dialysis

Albuminuria Stage	Albuminuria (mg/mmol)
A1	<3
A2	3 - 30
A3	>30

Other changes in bloodwork include:

- Decreased hemoglobin, hematocrit, and ferritin
- Decreased calcium
- Decreased bicarbonate (i.e., shift towards metabolic acidosis)
- Increased phosphate
- Increased potassium

Symptoms often begin to appear at stage G3b. Symptoms initially are mild but can progress and become severe as kidney function continues to drop. Symptoms include:

- Confusion
- Lack of energy
- Pruritis
- Lack of appetite
- Edema
- Lack of urination
- Lack of urination
- Nausea (in severe CKD)

Causes of CKD

Primary Causes	Secondary Causes
Glomerulonephritis	Hypertension (especially if uncontrolled)
Polycystic kidney disease	Diabetes (especially if uncontrolled)
Alport Syndrome	Acute kidney injury
Abnormal kidney development	Lupus
	Renal obstruction (e.g., kidney stones, benign prostate hypertrophy, tumour)
	Recurring urinary tract infections
	Certain medications (e.g., lithium)

Hypertension and diabetes are the cause of approximately two-thirds of all CKD cases.

RATIONALE:

Correct Answer:

- **Uncontrolled hypertension is a significant risk factor for kidney failure** - Uncontrolled hypertension can cause and worsen chronic kidney disease and lead to kidney failure.

Incorrect Answers:

- **Hypertension is not a well known risk factor for the development of chronic kidney disease** - If hypertension is well controlled, the risk of chronic kidney disease is minimized.
- **Blood pressure should be <130/80 mmHg to prevent the progression of kidney disease in all patients** - This is the blood pressure target for diabetics with chronic kidney disease. For non-diabetics with chronic kidney disease, the target blood pressure is <140/90 mmHg. A systolic blood pressure of <120 mmHg can be considered in select patients.
- **Kidney disease progression can be stopped by controlling hypertension** - Progression of renal failure can be slowed down, but not stopped if hypertension is well controlled.

TAKEAWAY/KEY POINTS:

Hypertension and diabetes are the most common causes of chronic kidney disease (CKD). It is possible to reduce the risk of CKD by optimizing control of these two conditions.

REFERENCE:

- [1] KDIGO 2012 clinical practice guidelines for the evaluation and management of chronic kidney disease. *Kidney International Supplements*. 2013;3(1). doi: 10.1038/kisup.2012.73.
- [2] KDIGO 2017 clinical practice guideline update for the diagnosis, evaluation, prevention, and treatment of chronic kidney disease – mineral and bone disorder (CKD-MBD). *Kidney International Supplements*. 2017;7(1). doi: http://dx.doi.org/10.1016/j.kisu.2017.04.001.
- [3] About chronic kidney disease. National Kidney Foundation. <https://www.kidney.org/atoz/content/about-chronic-kidney-disease>. Updated February 15, 2017.

The correct answer is: Uncontrolled hypertension is a significant risk factor for kidney failure

Question 6

ID: 54416

Correct

Flag question

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Which of the following symptoms can represent both chronic kidney disease and acute kidney failure?

Select one:

- Hyperkalemia ✓
- Increased urine output ✗
- Neuropathy ✗
- Low hemoglobin level ✗

Rose Wang (ID:113212) this answer is correct. Chronic kidney disease can be differentiated from acute kidney failure based on the patient's other symptoms and medical history.

Correct

Marks for this submission: 1.0/1.0.

TOPIC: Chronic kidney disease**LEARNING OBJECTIVE:**

To differentiate between signs and symptoms of chronic kidney disease and acute kidney failure.

BACKGROUND:

Chronic kidney disease (CKD) is defined by the presence of kidney damage or a decrease in kidney function lasting for at least three months. The first sign of CKD is often a reduction in creatinine clearance and/or proteinuria. The staging of CKD is as follows:

CKD Staging

Kidney Function Stage	eGFR (ml/min/1.73m ²)
G1 - normal or high	≥90
G2 – Mildly decreased	60 - 89
G3a – Mildly to moderately decreased	45 - 59
G3b – Moderately to severely decreased	30 - 44
G4 – Severely decreased	15 - 29
G5 – Kidney failure	<15 or on dialysis

Albuminuria Stage	Albuminuria (mg/mmol)
A1	<3
A2	3 - 30
A3	>30

Other changes in bloodwork include:

- Decreased hemoglobin, hematocrit, and ferritin
- Decreased calcium
- Decreased bicarbonate (i.e., shift towards metabolic acidosis)
- Increased phosphate
- Increased potassium

Symptoms often begin to appear at stage G3b. Symptoms initially are mild but can progress and become severe as kidney function continues to drop. Symptoms include:

- Confusion
- Lack of energy

- Pruritis
 • Lack of appetite
 • Edema
 • Lack of urination
 • Neuropathy

Causes of CKD

Primary Causes	Secondary Causes
Glomerulonephritis	Hypertension (especially if uncontrolled)
Polycystic kidney disease	Diabetes (especially if uncontrolled)
Alport Syndrome	Acute kidney injury
Abnormal kidney development	Lupus
	Renal obstruction (e.g., kidney stones, benign prostate hypertrophy, tumour)
	Recurring urinary tract infections
	Certain medications (e.g., lithium)

Hypertension and diabetes are the cause of approximately two-thirds of all CKD cases.

RATIONALE:

Correct Answer:

- **Hyperkalemia** - Chronic kidney disease can be differentiated from acute kidney failure based on the patient's other symptoms and medical history.

Incorrect Answers:

- **Increased urine output** - Increased urine output may represent chronic kidney disease but not acute kidney failure.
- **Neuropathy** - Neuropathy is a common symptom in chronic kidney disease but not in acute kidney failure.
- **Low hemoglobin level** - Low hemoglobin level can be a sign of chronic kidney disease but not acute kidney failure.

TAKEAWAY/KEY POINTS:

Chronic kidney disease symptoms may include hyperkalemia, hyperphosphatemia, hypocalcemia, metabolic acidosis, anemia, pruritis, and changes in urine output.

REFERENCE:

- [1] KDIGO 2012 clinical practice guidelines for the evaluation and management of chronic kidney disease. *Kidney International Supplements*. 2013;3(1). doi: 10.1038/kisup.2012.73.
- [2] KDIGO 2017 clinical practice guideline update for the diagnosis, evaluation, prevention, and treatment of chronic kidney disease – mineral and bone disorder (CKD-MBD). *Kidney International Supplements*. 2017;7(1). doi: http://dx.doi.org/10.1016/j.kisu.2017.04.001.
- [3] About chronic kidney disease. National Kidney Foundation. <https://www.kidney.org/atoz/content/about-chronic-kidney-disease>. Updated February 15, 2017.

The correct answer is: Hyperkalemia

Question 7

ID: 54417

Incorrect

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Life-threatening cardiac arrhythmias due to hyperkalemia can be treated with which of the following agents?

Select one:

- Digoxin IV ✕
 Furosemide IV ✕
 Sodium polystyrene sulfonate PO ✕
 Calcium gluconate IV ✓

Rose Wang (ID:113212) this answer is incorrect. Oral potassium binders do not work quickly enough in a life-threatening situation and will not treat the cardiac arrhythmia.

Incorrect
Marks for this submission: 0.0/1.0.

TOPIC: Chronic kidney disease

LEARNING OBJECTIVE:

To identify treatment options for hyperkalemia as it can present along with chronic kidney disease.

BACKGROUND:

Hyperkalemia can be identified:

Hyperkalemia severity and treatment

Severity	Serum potassium level (K^+)	Treatment
Mild	5.0 - 5.5 mmol/L	<p>Non-pharmacological treatment such as:</p> <ul style="list-style-type: none"> ▪ Reduce dietary sources of K^+ ▪ Optimize control of disease condition causing hyperkalemia ▪ Temporary or permanent discontinuation of K^+ increasing drugs
Moderate	5.6 - 5.9 mmol/L	<ol style="list-style-type: none"> 1. Non-pharmacological treatment 2. Repeat serum K^+ and kidney function lab work within 3 days 3. If second serum K^+ result is within the same range, consider administration of cation binding agent
Severe	≥ 6.0 mmol/L	<p>Treat pharmacologically as soon as possible if the patient is symptomatic or has abnormal electrocardiogram (ECG) results. Pharmacological treatments include:</p> <ul style="list-style-type: none"> • Insulin with glucose • Inhaled, nebulized, or IV β_2 agonists • Calcium gluconate • Furosemide • Cation binding agent <p>In addition to pharmacological treatment, use non-pharmacological treatment and repeat serum K^+ level within 3 days.</p>

Hyperkalemia can be treated pharmacologically via different mechanisms:

Insulin

- Insulin stimulates the activity of sodium-hydrogen antiporter, resulting in intracellular movement of sodium; this activates sodium-potassium ATPase pump, causing an intracellular shift of potassium

β_2 agonists

- β_2 agonists activate sodium-potassium ATPase pump, causing an intracellular shift of potassium

Calcium gluconate

- Calcium does not reduce serum K^+ but reduces the risk of arrhythmia ECG changes that are present as a result of hyperkalemia

Furosemide

- Furosemide increases urinary excretion of K^+

Cation binding agent

- Cation binding agents such as sodium polystyrene sulfonate bind K^+ and release sodium into the gut, resulting in fecal excretion of bound K^+

RATIONALE:

Correct Answer:

- **Calcium gluconate IV** - Intravenous calcium gluconate is used to treat potassium-induced cardiac arrhythmias.

Incorrect Answers:

- **Digoxin IV** - Digoxin is not indicated for life-threatening cardiac arrhythmia due to hyperkalemia.
- **Furosemide IV** - Furosemide will not treat life-threatening cardiac arrhythmia due to hyperkalemia.
- **Sodium polystyrene sulfonate PO** - Oral potassium binders do not work quickly enough in a life-threatening situation and will not treat the cardiac arrhythmia.

TAKEAWAY/KEY POINTS:

There are multiple mechanisms for treating hyperkalemia but calcium gluconate can also treat hyperkalemia-induced cardiac arrhythmias.

REFERENCE:

[1] Ezekowitz JA, et al. 2017 Comprehensive update of the Canadian cardiovascular society guidelines for the management of heart failure. *Can J Cardiol.* 2017;33(11):1342-1433.

[2] Elliot MJ, Ronksley PE, Clase CM, Ahmed SB, Hemmelgarn BR. Management of patients with acute hyperkalemia. *Can Med Assoc J.* 2010;182(15):1631-1635. doi:<https://doi.org/10.1503/cmaj.100461>.

The correct answer is: Calcium gluconate IV

Question 8

ID: 54418

Correct

Flag question

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Calcium carbonate is used to treat hyperphosphatemia associated with chronic kidney disease. Use of calcium carbonate may cause all of the following conditions EXCEPT:

Select one:

- Hypophosphatemia
- Abdominal discomfort

- Fluid retention

Rose Wang (ID:113212) this answer is correct. Calcium carbonate does not cause fluid retention.

- Hypoparathyroidism

Correct

Marks for this submission: 1.0/1.0.

TOPIC: Chronic kidney disease

LEARNING OBJECTIVE:

To understand the role of calcium supplementation in relation to high serum phosphate level with chronic kidney disease.

BACKGROUND:

Chronic kidney disease (CKD) is defined by the presence of kidney damage or a decrease in kidney function lasting for at least three months. The first sign of CKD is often a reduction in creatinine clearance and/or proteinuria.

CKD can also include other changes in bloodwork:

- Decreased hemoglobin, hematocrit, and ferritin
- Decreased calcium
- Decreased bicarbonate (i.e., shift towards metabolic acidosis)
- Increased phosphate
- Increased potassium

High serum phosphate levels, also known as hyperphosphatemia, can be treated by reducing dietary intake of phosphate (e.g., organ meat, fish, beer, cola, sardines, processed food, food additives).

Hyperphosphatemia can also be treated using phosphate binders such as calcium carbonate, sevelamer, or lanthanum carbonate. Phosphate binders work by reducing the amount of phosphate absorbed from food eaten. Calcium carbonate is often the first-line treatment, in addition to dietary modification, for two reasons: it is a cheap treatment option and it also treats the hypocalcemia that can occur in CKD.

Calcium carbonate supplements are taken a few minutes before eating a meal. It can cause several side effects:

- Gastrointestinal discomfort
- Hypercalcemia as it is a calcium supplement
- Hypophosphatemia as calcium binds dietary phosphate
- Hypoparathyroidism as parathyroid hormone release is stimulated by hypocalcemia and inhibited by hypercalcemia
- May be associated with kidney stones

RATIONALE:

Correct Answer:

- **Fluid retention** - Calcium carbonate does not cause fluid retention.

Incorrect Answers:

- **Hypophosphatemia** - Calcium supplements are used to decrease serum phosphate level, so hypophosphatemia is a potential side effect.

- **Abdominal discomfort** - This is a common side effect of calcium supplements.
- **Hypoparathyroidism** - Parathyroid hormone release is inhibited by hypercalcemia; therefore, calcium carbonate can cause hypoparathyroidism.

TAKEAWAY/KEY POINTS:

Calcium carbonate supplements bind phosphate uptake from dietary sources and are used as first-line treatment options for hyperphosphatemia associated with chronic kidney disease.

REFERENCE:

[1] KDIGO 2012 clinical practice guidelines for the evaluation and management of chronic kidney disease. Kidney International Supplements. 2013;3(1). doi: 10.1038/kisup.2012.73.

[2] Phosphorus and your CKD diet. National Kidney Foundation. <https://www.kidney.org/atoz/content/phosphorus>. Updated January 10, 2017.

The correct answer is: Fluid retention

Question 9

ID: 54419

Correct

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A patient with chronic kidney disease and creatinine clearance of 25 mL/min requires a diuretic. Which of the following options is the most effective and safe diuretic for this patient?

Select one:

- Hydrochlorothiazide ✗
- Furosemide ✓
- Spironolactone ✗
- Acetazolamide ✗

Rose Wang (ID:113212) this answer is correct. Loop diuretics such as furosemide will be safe and effective in causing diuresis for this patient.

Correct

Marks for this submission: 1.0/1.0.

TOPIC: Chronic kidney disease

LEARNING OBJECTIVE:

To understand the role of diuretics in chronic kidney disease.

BACKGROUND:

Chronic kidney disease (CKD) is defined by the presence of kidney damage or a decrease in kidney function lasting for at least three months. The first sign of CKD is often a reduction in creatinine clearance and/or proteinuria.

Other bloodwork signs include:

- Decreased hemoglobin, hematocrit, and ferritin
- Decreased calcium
- Decreased bicarbonate (i.e., shift towards metabolic acidosis)
- Increased phosphate
- Increased potassium

Symptoms include:

- Confusion
- Lack of energy
- Pruritis
- Lack of appetite
- Edema
- Lack of urination
- Nausea (in severe CKD)

As edema is a common side effect in moderate to severe CKD, diuretics are often given to CKD patients. When picking a diuretic, the following should be taken into consideration:

- Is efficacy reduced below a certain creatinine clearance?
 - Thiazide diuretics have been found to be less effective when creatinine clearance is <30 mL/min
- Will this diuretic increase or decrease potassium levels?
 - As hyperkalemia is a common complication of CKD, potassium-sparing diuretics should not be used if there are safer alternatives

RATIONALE:**Correct Answer:**

- **Furosemide** - Loop diuretics such as furosemide will be safe and effective in causing diuresis for this patient.

Incorrect Answers:

- **Hydrochlorothiazide** - Hydrochlorothiazide efficacy is significantly reduced in patients with creatinine clearance less than 30 mL/min.
- **Spironolactone** - Spironolactone is a potassium-sparing diuretic and therefore is not the safest option for this patient.
- **Acetazolamide** - Acetazolamide can lead to metabolic acidosis as it increases sodium bicarbonate excretion and is not the safest option.

TAKEAWAY/KEY POINTS:

When giving a diuretic or any other medication to a patient with chronic kidney disease, it is important to take into consideration the drug's efficacy and toxicity when creatinine clearance is reduced.

REFERENCE:

- [1] KDIGO 2012 clinical practice guidelines for the evaluation and management of chronic kidney disease. Kidney International Supplements. 2013;3(1). doi: 10.1038/kisup.2012.73.
- [2] About chronic kidney disease. National Kidney Foundation. <https://www.kidney.org/atoz/content/about-chronic-kidney-disease>. Updated February 15, 2017.

The correct answer is: Furosemide

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